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EPA ORD Annual Report

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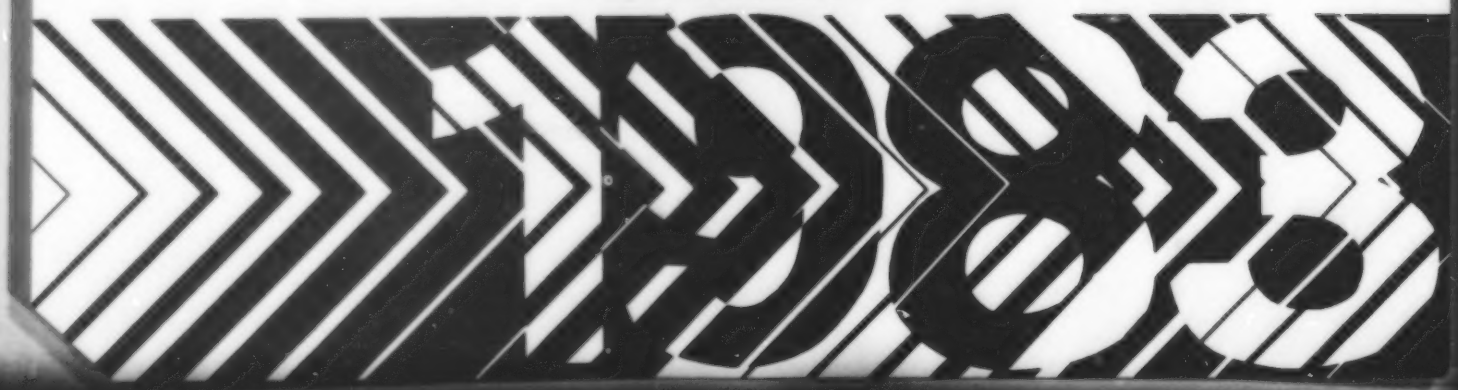

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16. ABSTRACT

This report describes the accomplishments of the Office of Research and Development (ORD) and its 14 laboratories is fiscal year 1983. During that year, researchers uncovered important and unexpected new information on how some major pollutants affect human health, developed less costly and more accurate tests for environmental toxicity, and assessed potential pollution from, and the cost effectiveness of numerous industrial and municipal sources of pollution. ORD also helped to estimate the cost of air pollution and to reduce the cost of controlling it. In addition, the program improved the methods used to detect hazardous wastes and the means available to destroy them.

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Introduction

Protecting the people from environmental hazards is an extremely complex task. Many environmental protection decisions involve sophisticated scientific data and must sometimes be made with incomplete or inadequate information. To have trust in these decisions, the people need to be shown that the decision makers are relying upon the best available scientific data and are interpreting that data in an objective manner.

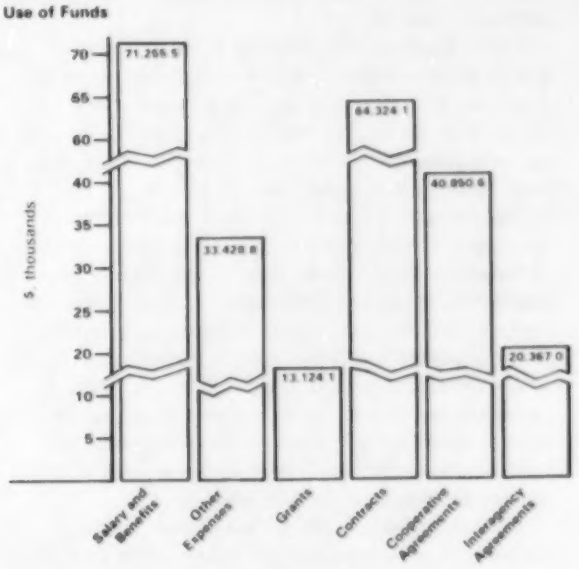
It is the role of the Office of Research and Development within the EPA to provide much of that scientific data and to interpret that data objectively for regulatory decision makers. In 1983 the productivity of this office towards that end was impressive. As you will read in this report, our researchers last year uncovered important and unexpected new information on how some major pollutants affect human health, we developed less costly and more accurate tests for environmental toxicity, and we assessed potential pollution from, and the cost-effectiveness of, numerous industrial and municipal sources of pollution. We helped to estimate the cost of air pollution and to reduce the cost of controlling it. And we improved both the methods used to detect hazardous wastes and the means available to destroy them.

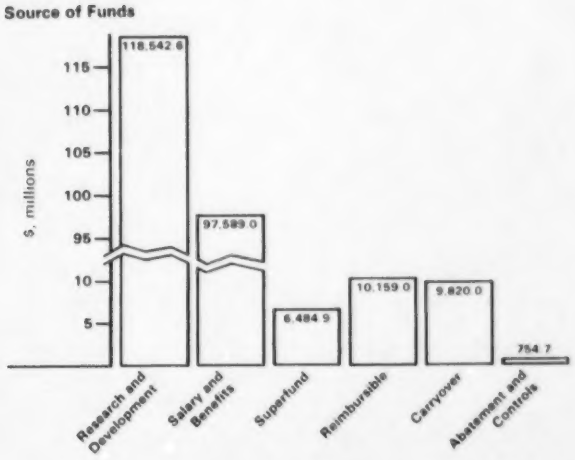
We hope that you enjoy this report. We look forward to an even more productive year in 1984.

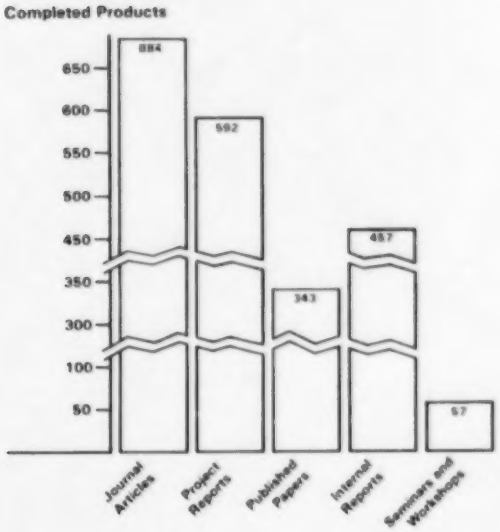
The Organization

The EPA's Office of Research and Development headquarters in Washington does the strategic planning and budgeting for a program of more than $250 million in research per year.

Our research is conducted out of 14 laboratories located from as far east as Narragansett, RI, to as far west as Corvallis, OR. We have major research centers in Cincinnati, OH and Research Triangle Park, NC. These laboratories report to five major headquarters offices which are organized along discipline lines: health; environmental processes and effects; environmental engineering and technology; monitoring systems and quality assurance; and health and environmental assessment.







OEPER

Office of Environmental Processes and Effects Research

This office studies the movement, fate, and effects of pollutants entering the environment and the food chain. The resultant research provides the scientific basis for predicting pollutant exposure that would occur from alternative approaches to environmental management and for determining the effects of pollutants in the ambient environment. The research is conducted through laboratories located in Narragansett, Rhode Island; Duluth, Minnesota; Athens, Georgia; Corvallis, Oregon; Ada, Oklahoma; Gulf Breeze, Florida; and Research Triangle Park, North Carolina.

A major focus of this office's 1983 research was on the ocean environment. Most pollutants that find their way into the ocean settle into and therefore exert their effects through sediments. However, traditional ecological assessment methods do not allow a simple, straightforward determination of the significance of contamination in sediments. To overcome this deficiency, researchers at the Environmental Research Laboratory in Corvallis, Oregon, developed and validated a quick and inexpensive bioassay technique for measuring the toxicity of marine sediments.

This bioassay technique can potentially be applied in regulatory programs. An early version of the bioassay was used for solid-phase testing in the EPA/U.S. Army Corps of Engineers dredged material permits program. A second regulatory use of the bioassay is in monitoring the extent of sediment toxicity. EPA Region X is currently using the amphipod bioassay in its baseline survey of Puget Sound.

Related work at the Corvallis laboratory should be of great benefit to clean-up efforts at hazardous waste sites. Currently, hazardous waste site clean-up decisions are based mainly on laboratory-derived "safe" levels for individual chemicals. In practice, this has major shortcomings, because it requires extensive chemical characterization of the site and is difficult to apply to sites where more than a single chemical is involved, as is usually the case. Experience has also shown that chemicals tested in a laboratory may not be toxic in the same way that they would be in the real world, where they may be chemically bound or otherwise not bioavailable.

To avoid some of these shortcomings, our researchers demonstrated a relatively simple set of screening bioassays that can be used to determine the toxicity and bioavailability of unknown mixtures of chemicals in soil or leachate samples from hazardous waste sites. To date, these screening bioassays have been used to identify biological hazards that were not identified by chemical characterization. Our new approach has already had a major influence on site clean-up decisions. At present our researchers are expanding these screening tests to include indicators of chronic exposure effects.

The Environmental Research Laboratory in Athens, Georgia, provides important predictive tools to EPA program offices and regions and to state and local officials responsible for controlling potentially toxic chemicals as well as conventional water pollutants. Studies of chemical and microbial processes that decompose man-made chemicals in the environment lead to the development of mathematical models that predict the fate of such chemicals. One such study, completed in 1983 and entitled "Influence of Algae on Photolysis Rates of Chemicals in Water," revealed that some chemicals are decomposed significantly faster in natural waters than in distilled water in the laboratory. An understanding of this mechanism provides for the development of predictive equations that take advantage of natural treatment processes in evaluating the potential environmental impact of chemicals.

In August, 1983, EPA's Office of Water designated the manual, "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants," produced by the Athens, Georgia, laboratory as official national guidance for states in planning under the Areawide Wastewater Management Program. The manual is an update of a 1977 manual that dealt with conventional pollutants only, and it reflects major new developments in assessing the fate and transport of toxic organic pollutants.

Another major challenge facing state and local environmental officials is the difficulty in reliably identifying and measuring unsuspected chemical

pollutants in water. To assist in this effort, researchers at the Athens laboratory developed a master analytical scheme (MAS) for identifying and measuring all major volatile organic chemicals in water. This scheme provides a set of protocols for identifying and measuring a broad spectrum of organic chemicals present in a variety of water types. Its use allows for repetitive analysis of selected organic pollutants for which individual methods have not been developed. The entire MAS system was field evaluated in 1983 and will be available in handbook form in 1984.

To establish the effectiveness of certain natural treatment systems that remove toxic pollutants from water, the Environmental Research Laboratory in Ada, Oklahoma, is investigating a system of waste application called overland flow. In 1983, in concert with the U.S. Army Cold Regions Research and Engineering Laboratory, the researchers at Ada found that overland flow systems are effective in removing trace levels of a variety of organic priority pollutants from municipal wastewater. Researchers determined the removal efficiency for 13 trace organics on an outdoor, prototype overland flow land treatment system and developed a model based on the two-film theory. This model can be used to predict organic chemical removal by overland flow treatment systems.

Our lack of knowledge of the exact compounds present in wastewater discharges and of the net effect of various combinations of compounds makes the control of toxicity through chemical criteria difficult. In complex effluents, mixtures are formed which have an unknown toxicity. Such situations call for a direct measure of chronic toxicity to aquatic life. To fill this need, researchers at the Environmental Research Laboratory in Duluth, Minnesota, developed and field tested both acute and seven-day chronic toxicity tests for exposure of fish to complex effluents. These tests can be used to accurately predict the biological impact of complex effluents on receiving streams.

Chemical industries are often required to produce sufficient scientific information on a particular chemical to allow for the development of an accurate environmental risk assessment for that chemical. The test procedures and guidelines that have been available are based upon the examination of a single species or a single environmental process and may not adequately reflect the range and complexity of a chemical's behavior in nature. To improve this situation, researchers at the Environmental Research Laboratory in Narragansett, Rhode Island, developed a single test system that incorporated a sufficient number of complex chemical, biotic, and physical properties to simulate natural systems and thus to allow more accurate estimates of the behavior of a chemical and its biotic effects. In 1983, these efforts produced a test protocol and support document for a site-specific marine microcosm. The protocol enables an investigator to establish the fate, transport, and ecological effects of a chemical by using a single test. The experimental microcosm produces more accurate data for developing risk assessments for a chemical than does the battery of single-variable test systems historically in use. At the same time, the microcosms are cost-competitive with the simple test systems.

Increased drilling in the outer continental shelf and near-shore oil and gas exploration have generated concern over potential environmental impacts of marine disposal of spent drilling muds and cutting fluids. EPA is required to issue permits for discharges from oil and gas rigs into outer continental shelf waters. To aid in developing necessary hazard assessments, researchers at the Environmental Research Laboratory in Gulf Breeze, Florida, initiated projects to identify the effects on biota of spent muds and fluids and to determine actual concentrations in the field. As the result of two major workshops held in 1983, these efforts led to the development of a preliminary model simulating the fate and effects of drilling muds discharged into marine waters. The model will be useful to decision makers as a part of a data base for writing the required National Pollutant Discharge Elimination System (NPDES) permits for offshore drilling.

Another major focus of the Office's research in 1983 was on transport, fate, and effects of air pollutants. At the Environmental Sciences Research Laboratory in Research Triangle Park, North Carolina, research continued on the development of improved dispersion models applicable to complex terrain, particularly in the mountainous West, where energy development is necessary. Our researchers coupled two air quality simulation models to predict concentrations of pollutants from elevated, continuous point sources of emissions located in mountain valleys. The research objective was to develop improved site-specific air quality models for analyzing the effects of oil shale

petroleum development on pristine wilderness areas and on air quality standards for criteria pollutants.

One of the major air pollutants regulated by EPA is ozone. In order to control ozone concentrations, emission levels of volatile organic compounds (VOCs), which contribute to ozone formation in the atmosphere, must be reduced. The reactivity of individual VOCs, and, therefore, their potential to produce ozone in the atmosphere, varies greatly depending on such factors as chemical structure and volatility. One widely used VOC suspected of contributing to ozone problems is perchloroethylene (PCE). To assist EPA's Office of Air Quality Planning and Standards in assessing the importance of PCE in producing atmospheric ozone, researchers from the environmental sciences laboratory conducted a number of smog chamber and theoretical experiments to simulate atmospheric reactions of PCE. The results of these experiments, which indicate that PCE is not very reactive in producing ozone, will be used by EPA in advising the states on PCE emissions control policy.

While it has long been known that present levels of ambient ozone can damage vegetation, including agricultural crops, the response of plants to stress varies widely with the conditions under which the plants are grown. Hence, it has not been possible to determine with confidence the degree of plant damage caused by present ozone levels or to translate these losses into economic terms. Researchers at the Corvallis, Oregon, laboratory have developed and compiled ozone exposure/crop yield data for agricultural crops that represent 75% of U.S. acreage. Yield losses for individual crops at present ambient levels of ozone range from negligible to 20%. Preliminary economic assessments using these data indicate that a 25% reduction in ambient ozone would produce annual benefits of approximately $800 million in the Midwest and $150 million in California.

OEET

Office of Environmental Engineering and Technology

This office conducts research to assess pollution from industrial and municipal sources in order to improve pollution controls by determining the cost and performance of control measures and technologies. This research is conducted through the Municipal Environmental Research Laboratory in Cincinnati, Ohio, and two Industrial Environmental Research Laboratories, one in Research Triangle Park, North Carolina, and the other in Cincinnati, Ohio.

High-temperature incineration is becoming an increasingly attractive alternative for waste disposal as land disposal becomes more complicated and expensive. In 1983, the industrial laboratory in Cincinnati continued a program encompassing laboratory and pilot-scale evaluations of waste destruction capability in high-temperature processes, field performance of incinerators, and innovative processes. During 1983, the laboratory completed the multi-purpose Combustion Research Facility in Jefferson, Arkansas. This facility contains several pilot-scale incinerators and will be used to evaluate process reliability, causes of process failure, and control systems that are currently underway. The facility will also be used by the Office of Solid Waste for special test burns.

Millions of gallons of hazardous wastes are burned annually in boilers and industrial processes. Present regulations exempt these wastes from control standards, since they are being used as fuel. During 1983, field investigations were conducted at twelve boilers and seven other industrial processes throughout the country to evaluate emissions resulting from this combustion. The Agency will use the results of this work to reevaluate the exemption for boilers and processes. In 1983, the industrial laboratory in Cincinnati completed an evaluation of the combustion of waste oil in small boilers that will provide a foundation for regulating waste oil used as fuel.

Hazardous substances may now be destroyed at the site where they are collected, either during clean-up operations at spills or at uncontrolled hazardous waste sites. Our municipal laboratory in Cincinnati has designed, constructed, and tested a mobile incineration system that has this capability. The mobile incinerator was tested in 1983 and found to be especially useful for treating highly toxic organic chemicals where transportation of the chemicals from the site is not practical. This incinerator consists of four trailers that house equipment to incinerate hazardous substances at 2200°F. The system, thus far, has efficiently destroyed test organics and has met air emission requirements. For instance, in a trial burn, PCBs were destroyed at an efficiency of 99.9999%. Constructed for the most part with commercially available technology, the mobile incinerator was designed as a prototype. Its success has already inspired several commercial variations on the concept.

In another 1983 effort related to hazardous waste control, researchers at the municipal laboratory developed a handbook on the slurry trench cut-off wall, a useful groundwater barrier at uncontrolled hazardous waste sites. The handbook contains information on all phases of design, construction, and performance of slurry trench cut-off walls as applied to uncontrolled hazardous waste sites.

Uncontrolled hazardous waste deposits may be a major source of the volatile compounds that can be found in some drinking water supplies. To assist EPA in reviewing these compounds for possible regulation, municipal laboratory researchers compiled a report with exhaustive information on 16 synthetic organic compounds. The properties of these chemicals are summarized and each compound is discussed in terms of molecular structure, other names, some principal uses, and treatment information. A discussion section on treatment alternatives includes information on conventional treatment, aeration, adsorption, and boiling.

Reducing energy use is prompting the wastewater treatment industry to promote installing fine bubble ceramic diffuser aeration systems. As the result of cooperative research between the Los Angeles County Sanitation Districts and the municipal laboratory, the Districts are saving about 50% of the energy formerly used for aerating

wastewater at their Whittier Narrows activated sludge plant—savings made possible by replacing coarse bubble diffusers with a mixed system of fine bubble ceramic domes and discs installed in a total floor coverage grid pattern. Additional cooperative studies in the United Kingdom, Europe, and the United States have led to a tripartite agreement between EPA, the British Water Research Centre, and Environment Canada to demonstrate an optimized, automated, full-scale fine bubble diffuser aeration system at Rye Meads, England, that is maximizing aeration energy savings.

The high cost of the energy needed to operate sewage sludge incinerators is responsible for shutting down 15 to 20 percent of the incinerators constructed since 1970. This problem prompted the municipal laboratory's agreement with Indianapolis, IN, to determine if fuel requirements for sewage sludge incineration could be reduced. As a result, about $1 million a year in fuel costs are being saved. The demonstration also brought the incinerators into compliance with air pollution regulations—saving another $3 million. Instrumentation and equipment costing $250,000 and improved operating methods brought about these savings. Wastewater treatment plants in Nashville, Hartford, Buffalo, and others that have adopted this mode are saving over 50 percent of the fuel use—and their payback periods are even shorter than that of Indianapolis because their capital expenditures for new equipment were less.

A 3-1/2 year study identified and quantified specific causes of nonperformance and noncompliance at publicly owned, municipal sewage treatment works (POTWs); through Comprehensive Performance Evaluations (CPEs), 70 factors adversely affecting performance were identified. When a new systematic approach—a Composite Correction Program (CCP)—was used at 13 test sites, 11 of the noncomplying POTW's were brought into compliance without major capital expenditures. The Cincinnati municipal laboratory estimates that applying the CCP to all 103 comprehensively evaluated plants would have raised compliance levels from 36 to 86 percent. Both private sector and state pollution control authorities are now adapting the CPE/CCP concepts.

Lead levels in drinking water can result from the use of lead service lines and improper use of lead/tin solder in household plumbing; bacteriological deterioration and operational problems can result from the formation of tubercles and loss of disinfectant residuals, or corrosion products can form from the deterioration of distribution system materials, such as asbestos-cement pipe. The municipal laboratory's work with the City of Seattle has successfully demonstrated how to control water quality in the distribution system by adding chemicals that counteract the natural aggressiveness of the water. From this priority research will come the basis for regulating the use of lead/tin solder in household plumbing connections and a data base for understanding the persistence of bacteriological compliance problems in distribution systems despite the maintenance of a disinfectant residual. The research will also provide the foundation of a program for monitoring corrosion products in distribution systems and will further an understanding of the economic impact of water quality deterioration and of the cost of distribution system repair, replacement, and renovation.

Sulfur dioxide (SO_2) is both a criteria pollutant and one of the major contributors to acid deposition. The electric utility industry is the major source of SO_2 emissions. For several years, the industrial laboratory in Research Triangle Park, North Carolina, has been conducting research on flue gas desulfurization (FGD) processes to control SO_2. In one of these, the dual alkali FGD process, SO_2 is absorbed by a solution of sodium salts in a gas-liquid contactor, or scrubber. The waste stream from the scrubber is then mixed with a slurry of lime (calcium oxide) or limestone (calcium carbonate) to produce a solid waste product of calcium sulfite and sulfate, regenerating the sodium solution for recycle to the scrubber. A full-scale demonstration of the lime-based dual alkali process at Louisville Gas & Electric Co. was completed in 1983 with issuance of the final report. Long-term operation at high SO_2 removal efficiency (over 90%) and a high reliability (less than 10% downtime) were successfully demonstrated at this high-sulfur, coal-fired power plant.

Combustion of fossil fuels in power plants also contributes a significant amount of particulate matter to the atmosphere. The North Carolina industrial laboratory has sponsored projects which, in 1983, yielded major improvements to the two most common types of currently used particulate control technology—electrostatic precipitators (ESPs) and fabric filters. Our researchers developed and then demonstrated, with the cooperation of the

Electric Power Research Institute and Southern Company Services, sodium conditioning as a means of allowing coal-fired electric plants equipped with hot side electrostatic precipitators to meet new source performance standards without periodic shut downs or operation at reduced load. Sodium conditioning, which involves the addition of trace amounts of sodium to the coal feed, is inexpensive and reliable, and existing systems can be easily adapted to exploit its benefits. For example, at a test conducted at a Gulf Power Company plant in Lynn Haven, Florida, sodium conditioning reduced particulate emissions by more than an order of magnitude. The results of this demonstration mean that most of the 11,000 MW of electrical generating capacity equipped with problem precipitators can now meet New Source Performance Standards (NSPS) or State Implementation Plans (SIPs) without periodic outages or operation at reduced load. In addition, sodium is less expensive by a factor of at least ten than alternative methods of meeting standards.

Another particulate research effort involves two-stage ESPs in series for power plants using low-sulfur coals. When low-sulfur coals are burned, the fly ash produced is difficult to collect in cold-side precipitators, because the dust is resistive to the electrical charge directed to the particles. A two-stage precipitator was developed for pilot unit demonstrations at both TVA Bull Run and Public Service of Colorado facilities. Results indicate that two-stage precipitators substantially improve the performance of ESPs when low-sulfur coal is burned and provide potential for significant further improvements. This capability could be especially important should future regulations require reductions in both sulfur emissions and inhalable particulate emissions.

The burning of fuels in the many types of combustion equipment is the major source of nitrogen oxide (NO_x) emissions in this country. Nitrogen oxides are among the criteria pollutants and contribute to atmospheric oxidants and acid deposition. The industrial laboratory in North Carolina recently identified control technologies that have great potential for reducing NO_x emissions in a variety of combustion processes. In-furnace NO_x reduction (reburning) technology is based on the injection and burning of a portion of the fuel in a secondary zone beyond or downstream of the primary combustion zone. It is being investigated for its applicability to U.S.-designed combustion systems. In 1983, tests were performed on small gas-fired and coal-fired pilot-scale combustors, and in 1984, the studies will be extended for coal-fired systems and initiated for oil-fired systems. In general, results indicate that NO_x reductions of 50 percent or greater from the NO_x levels entering the secondary combustion zone can be achieved with this technology.

Another advanced technology being evaluated for NO_x reduction is a low-NO_x heavy oil burner with a precombustor design. In 1983, a prototype burner was fabricated and installed on an enhanced oil recovery steamer operating in a California oil field. Performance test results have shown acceptable overall performance with a high-nitrogen fuel oil.

The North Carolina laboratory is also conducting the Limestone Injection Multistage Burner (LIMB) program, the major goal of which is to develop effective technology that will reduce both SO_x and NO_x emissions for coal-fired boilers. LIMB technology is very advantageous because it is potentially retrofitable to large and small coal-fired boilers. It is also lower in cost than any available alternative and can control both SO_x and NO_x—the two major acid rain precursors. During the past year, the laboratory's LIMB research has identified and quantified the major variables governing sulfur capture. It has shown that sorbent surface area, which is the key to sulfur capture efficiency, is affected by combustion conditions and that very high sorbent surface areas can be achieved under proper conditions. In addition, tests have verified that the program's NO_x and SO_x reduction goal of 50% or greater is achievable in experimental systems operated under proper conditions. Ongoing research will result in a wall-fired utility boiler demonstration to be initiated in FY 84 and completed by the end of 1987.

Fugitive emissions from major industries are problematic sources of air pollution in some areas. In the copper smelting process, a cylindrical furnace, called a converter, transforms copper matte, produced from copper ore concentrations in a smelting furnace, to elemental copper. This process generates a large quantity of pollutants, many of which become fugitive emissions containing sulfur dioxide, arsenic, and lead. These are emitted within the smelter and exit through a roof ventilation system. This results in exposure of the worker through high pollutant concentrations at ground level, close to the smelter. In 1983, the industrial research laboratory in Cincinnati provided

technical assistance to EPA's air office and regional office in Seattle, Washington, on affordable technology for controlling converter fugitive emissions.

With the assistance of the Cincinnati industrial researchers, an air curtain system was installed at the American Smelting and Refining Company's (ASARCO) Tacoma copper smelter in Tacoma, Washington. The air curtain is a sheet of moving air that prevents air on one side of the curtain from mixing with air in the other side. The curtain is created by blowing compressed air from either a plenum or a row of air nozzles located across the top of the converter area into an exhaust duct. Air is pulled into the curtain, capturing the fugitive emissions, which are then ducted to a control device. The air curtain system installed in Tacoma demonstrated an efficiency of more than 90% emissions control. EPA has since designated the air curtain secondary hooding system as "best available technology" (BAT) for this purpose.

Another type of fugitive particulate emission is that generated by vehicular traffic on roads and parking lots and wind blown dust from open, nonvegetated areas and piles of raw materials (e g., coal and ore). Unpaved roads have been shown to be the most significant of these sources. At steel plants, they may contribute one half or more of the total plant particulate emissions. Controlling these emissions, especially from unpaved roads, in lieu of controlling fugitive emissions from process equipment, is a central feature of the emission trade plans (bubbles) proposed by many steel plants. During 1983, the industrial laboratory in North Carolina sponsored long-term tests of two unpaved road chemical dust suppressants at two steel plants. For the first time, the initial and subsequent decay in the dust suppressant effectiveness of these chemicals has been quantified over a range of particle sizes, including the PM10 fraction (particles less than 10 microns in diameter). Suppressant effectiveness for PM10, while initially very good, was found to decay more rapidly for smaller particles than for larger particles. The results are assisting the Office of Air Quality Planning and Standards to develop regulations for open dust sources and review proposed bubble plans.

There are more than 80,000 metal coating facilities in the United States, including metal furniture, vehicle, and large appliance coating plants. When organic solvent-based coatings are applied to metals, volatile organic compound (VOC) emissions, precursors to photochemical smog, are emitted to the atmosphere. Our industrial laboratory in Cincinnati demonstrated that the amount of air that flows through the curing oven and subsequently through an air pollution control system can be reduced significantly using a microprocessor to control ventilation air flow rates. The Mack Trucks, Inc., Allentown, Pennsylvania site was used for testing the microprocessor technique. The microprocessor allowed a reduction in air flow that lowered energy and operating costs of the oven and the incinerator by 85% while ensuring optimal VOC destruction efficiency in the incinerator. For new curing oven installations, the microprocessor system will allow for a smaller control system and will result in capital and operating cost savings.

Research conducted by the industrial laboratories in North Carolina and Cincinnati, Ohio, has also contributed significantly to the development of an environmentally acceptable synthetic fuels industry. In the absence of industry-specific regulations, regional and state officials are relying on existing permit systems to establish pollution control requirements for new synthetic fuel facilities. In addition to existing permitting requirements, Section 131(e) of the 1980 Energy Security Act (PL 96-294) requires that any contract for financial assistance made by the U.S. Synthetic Fuels Corporation (SFC) include a plan for monitoring environmental and health-related discharges during the construction and operation of the synthetic fuels project and that these plans be reviewed by the consulting agencies—EPA and DOE. To support these efforts, an environmental monitoring reference manual for synthetic fuel facilities was completed, and a series of process-specific pollution control technical manuals was prepared. The manuals summarize process, discharge, and pollution control data on coal conversion and oil shale technologies.

OMSQA

Office of Monitoring Systems and Quality Assurance

Monitoring systems and quality assurance research develops the tools and protocols used by EPA, states, and the regulated community to demonstrate compliance to permits, regulations, and standards. Additionally, this office and its associated laboratories develop guidelines and protocols for cost-effective and accurate environmental measurement data and assure that such data is of known and documentable quality. As they are developed, these tools are integrated into EPA's research and operational monitoring programs wherever the quality of environmental measurement data is critical to the credibility of the program outputs. Research in these areas is conducted at three ORD laboratories: one Environmental Monitoring and Support Laboratory at Cincinnati, Ohio, and two Environmental Monitoring Systems Laboratories, one at Research Triangle Park, North Carolina, and another at Las Vegas, Nevada.

The Cincinnati laboratory plays a central role in providing the technical inputs to the "Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136," which is one of the few regulations for which the Office of Research and Development has promulgation responsibility. This regulation is required by Section 304(h) of the Clean Water Act and plays a pivotal role in the National Pollutant Discharge Elimination System (NPDES) permits program and also directly supports the Office of Water Program's Effluent Limitation Guidelines and Secondary Treatment regulations.

A principal Cincinnati research effort in 1983 was the revision of 40 CFR Part 136. Specifically, 18 formal interlaboratory validation studies were completed which verified that the analytical methods developed by this laboratory for the priority pollutants are generally applicable to treated industrial wastewater discharges. These include novel methods developed for analysis of trace organic priority pollutants in complex industrial wastewater matrices. Validation studies were included for various alternate test procedures based upon atomic absorption and inductively coupled plasma techniques for the analysis of trace inorganic toxic priority pollutants.

The Safe Drinking Water Act requires annual certification of drinking water analytical laboratories. The Cincinnati laboratory developed and provided a sample series for each contaminant for which an MCL (Maximum Contaminant Level) was listed in the primary drinking water regulations and amendments. New series samples were designed, prepared, and verified by analyses for each semi-annual study of over 1,000 laboratories. Each study covered 22 contaminants at two concentration levels. The laboratory conducted performance evaluations in 1983 in which over 1,500 laboratories participated.

In 1983, the Cincinnati laboratory revised the widely used "Handbook" for Sampling and Sample Preservation of Water and Wastewater" by updating the definitions of various sampling procedures and adding current literature references and sampler characteristics. The same laboratory published a special report on viruses in the environment. This report, by non-EPA scientific leaders in environmental virology, focused attention on research needs in virus monitoring. In addition, the laboratory published a handbook entitled "Methods for Use of Caged Molluscs for *in-situ* Biomonitoring of Marine Sewage Discharges." Approximately 100 tests were completed on four reference toxicants to standardize the toxicity response of four species of fresh water organisms. Microbial toxicity tests currently used in research were screened for their suitability in site-specific water quality criteria development. A report on the identification of estuarine invertebrates was also published in 1983.

The largest and most work-intensive quality assurance program in the Office of Research and Development was the support provided to the Superfund National Contract Laboratory Program. That program is responsible for the quality assurance of all sample analyses performed by the Superfund programs. To date more than 50 contractors have been involved in completing the analysis of 50 to 70 thousand samples. The three environmental monitoring laboratories have established a comprehensive quality assurance program that starts with a review of analytical

protocols before the Invitation to Bid. The laboratories provide for pre-award and post-award blind samples analysis. The participating laboratories are reviewed quarterly for performance, personnel, and management. The Las Vegas laboratory performs a 10% data audit to assure the provision of "known data." A standards and reference sample bank is maintained for the provision of routine quality assurance blanks and blind samples as well as "pure" samples for equipment calibration.

It is now possible to assess whether the fixed monitoring stations used to determine compliance with the carbon monoxide (CO) National Ambient Quality Standard (NAAQS) accurately represent the extent of actual population exposure to CO. At the request of EPA's air and mobile sources regulatory offices, the monitoring laboratory in North Carolina conducted a study that used portable monitors to measure the personal exposure to CO of residents of the metropolitan areas surrounding Denver, Colorado, and Washington, DC. Results to date indicate that in each area, a certain percentage of the population will sustain CO exposures in excess of those predicted based on fixed site monitors, that in both areas, a certain percentage of the population exposures are above current NAAQS, and that the major contributing factor to a person's exposure is the amount of time spent commuting to and from work.

A related study seeks to demonstrate methods to measure human exposure to toxic substances in air and drinking water. This "total exposure assessment methodology" (TEAM) study measured 20 toxic, carcinogenic, or mutagenic organic chemical compounds in the air and drinking water of 350 residents of Bayonne and Elizabeth, New Jersey. Personal air samplers were carried by each person, and drinking water samples were collected for each participant during a 24-hour sampling period. The information collected was used to estimate the distribution of exposures to target substances for the entire population of an industrial/chemical manufacturing area. In 1984, a comparable study is being carried out in a metropolitan area in California.

In 1983, researchers at the monitoring laboratory in Las Vegas enhanced the Agency's ability to assess the environmental risks of numerous potentially hazardous chemicals in a standard manner which relies upon models that simulate fate and transport processes in the environment. Before models can be applied with confidence, they must be verified. The steps of the validation process and the methods used to collect input and output data were not standardized. An interim guidance document for field validating aquatic fate and transport models was developed by Las Vegas laboratory personnel through an intensive examination of the literature and discussions with model developers.

Two separate approaches were then utilized to evaluate the field validation process. One was to test the interim guidelines by employing them to evaluate the fate and transport model, EXAMS, in two aquatic environments—a river and a pond. The other approach involved contacting leading researchers involved in model validation and revising the guidelines based upon their experience. The result was a more complete and useful document for standardizing EPA's approach to aquatic field validations. An additional benefit is that applying the standard approach demonstrated in the guideline will provide a number of mutually compatible data bases.

Adequate control of hazardous waste sites requires monitoring the unsaturated zone beneath them. If wastes from a hazardous waste site are moving in the subsurface, it is important to detect the pollutants before they reach groundwater aquifers. In response, researchers at the Las Vegas laboratory developed a comprehensive description of equipment and methods available for monitoring the subsurface zone above the water table. At the request of the Office of Solid Waste, the Office of Research and Development presented a series of courses in 1983 on this material to permit writers and produced a draft monitoring manual to be developed into official EPA guidance.

A priority program at the Las Vegas laboratory has been the demonstration and application of geophysical techniques to the subsurface mapping of leachate plumes emanating from hazardous waste sites. The laboratory has completed the first phase of its program with the publication of "Geophysical Techniques for Sensing Buried Wastes and Waste Migration." The study emphasized cost-effective investigations at waste sites. The integrated, phased approach recommended by the study includes: (1) preliminary site assessment involving aerial photography, on-site inspections, and the study of site geology, (2) the use of metal detectors, magnetometry, ground penetrating radar, electromagnetics, resistivity and

seismic refraction to pinpoint buried wastes, estimate quantities, and delineate plumes of conductive contaminants in groundwater.

The research efforts in the RCRA research program and the Superfund program established a geophysical support program. The objective of the program is to provide technical assistance to the Emergency Response Team, the Office of Emergency and Remedial Response, and the EPA Regions on geophysical sensing at uncontrolled and abandoned hazardous waste sites. Geophysical methods will be used to identify subsurface anomalies and map three-dimensional contaminant leachate plumes and/or to locate buried wastes. The methods will provide relatively quick and inexpensive preliminary information for site assessments and preliminary investigations, subsurface characterization prior to placing and digging wells, and a significant reduction in the cost of cleanup and monitoring.

A workshop was held in 1983 on monitoring research requirements in siting and operating hazardous waste disposal facilities in temperate zone wet environments. The discussion and presentation were designed to assist EPA in determining state-of-the-art research needed for evaluating a wet environment's appropriateness for hazardous waste disposal and for determining special monitoring considerations for land disposal in various wet environments.

OHR Office of Health Research

The mission of the health research office is to provide information that enables the Agency to estimate more accurately the effects on humans of exposure to environmental pollutants. It develops dose response data to determine possible adverse health effects, test methods to generate dose-response data, and improved methods for use in extrapolating animal data and high-to-low dose exposures to predict human health risks from environmental exposures. This research is conducted through the Health Effects Research Laboratory.

One increasingly important area of investigation is the potential health effects of radiofrequency (RF) radiation. EPA is developing guidelines to control exposure of the public to RF radiation. In 1983, the health effects laboratory published a compilation of existing, reliable information on the biological effects of RF radiation. This document addresses the frequency ranges of 500 kHz to 100 GHz. It summarizes data on the interaction between RF radiation and biological systems from four perspectives: RF-energy induced core temperature increase, whole-body-averaged specific absorption rate, exogenous energy burden as a percentage of resting metabolic rate, and actual human experiences documented in epidemiological studies. This scientific summary provides the health effects data base upon which the Agency can build exposure guidelines as necessary.

A major limitation on our ability to determine precisely the human health effects of exposure to potentially dangerous pollutants is that experiments which place humans at risk are unacceptable; however, with our sophisticated clinical laboratory facilities, it is possible to perform safe, controlled clinical studies of the effects of certain air pollutants on human volunteers. Currently, exposure chambers are used to generate controlled atmospheres for gases such as SO_2, O_3, CO, and NO_2, and for aerosol particles such as ammonium sulfates and nitrates. One important clinical study, reported in 1983, showed that the range of responses to ozone among otherwise normal, healthy, young males is so broad that there is not a "no-effect" level, as previously assumed. Also, it identified a large sub-population of otherwise normal, healthy people whose airways are hypersensitive to ozone.

Health effects researchers also conducted a study characterizing the sensitivity of asthmatics to sulfur dioxide. Subjects of the study were 27 nonsmoking males, 18 to 35 years of age, with a history of asthma. The subject sample was restricted to asthmatics with non-specific, hypersensitive airways. Each subject participated in four randomly ordered ten-minute chamber exposures, each exposure separated by at least one week. Exposure concentrations ranged from 0.00 ppm (clean air) to 2.00 ppm sulfur dioxide. The data indicate that slightly more than 25% of the subjects demonstrated sensitivity at less than 0.5 ppm, while all but about 20% were sensitive at concentrations greater than 1.75 ppm sulfur dioxide. The median sensitivity for all subjects was at 0.72 ppm. The results of these studies will provide important input into EPA's sulfur dioxide standard revision process.

With regard to another major air pollutant—particles—it is the size of the particle which determines where it will be deposited in the lung. Smaller particles are inhaled more deeply and are not as easily expelled as larger particles and thus may pose greater health risks. Here we define smaller particles as those below 10 microns in size (approximately three times the diameter of a human hair). To clarify the role of size in determining the effects of particles, our researchers developed a mathematical description of inhaled particle behavior suitable for dosimetry of the human upper respiratory tract, larynx, and ciliated airways. The model permits the Agency to predict the behavior of particles which cannot be studied experimentally in humans because of the risks involved. This model's predictions proved to be very accurate. When upper respiratory tract and larynx filtering efficiencies are incorporated in the model, theoretical calculations of aerosol deposition agree with dose data reported in the scientific literature.

The testing of chemicals for potential human health effects can be an expensive undertaking. Testing costs are a significant burden on industry and government alike. To help relieve this burden,

health effects researchers are working to expand the number, variety, and cost effectiveness of tests available.

Although *in vitro* tests tend to be both quicker and less expensive than *in vivo* (live animal) tests for related endpoints, the *in vitro* tests are currently not widely accepted as substitutes. For the *in vitro* tests to become accepted as substitutes, their results must agree well with those in the related animal test, and there must be a plausible reason for the agreement. Evaluating and improving the agreement between the *in vitro* and *in vivo* tests is part of the health effects laboratory's efforts to improve methods for testing.

As part of this effort, in 1983, the laboratory published two series of articles on short-term tests for carcinogenesis. One series dealt with the ability of a variety of tests to predict the effects of combinations of pollutants. The relative inexpensiveness of the short-term tests makes them an appealing choice for evaluating combinations of pollutants. The other series dealt with the use of human cells as targets in test systems. The use of human cells in short-term tests tends to improve their acceptance as predictors of effects in man. While neither series of papers has singlehandedly altered the acceptance of the short-term tests as substitutes for animal tests, each series has contributed to our understanding of the appropriate use of the short-term tests.

In the past, health effects research on pesticides was focused on developing test methods for industry to use to register chemical pesticides. Although microbial agents have been registered as pesticides for quite some time, testing protocols were not provided to industry for guidance. These agents were registered on a case-by-case basis. In 1983, the health effects laboratory provided data to EPA's pesticides office for inclusion in testing guidelines for industry to follow in registering microbial pesticides. These guidelines are currently in effect.

Coal-tar based paints and coatings have long been used to prevent corrosion in potable water systems. The relatively high content of polycyclic aromatic hydrocarbons (PAHs) present in coal tar suggests that these coatings might be a potential source of carcinogen exposure in drinking water that has contacted such surfaces. To determine if this is the case, health effects researchers compared the mutagenic and carcinogenic potentials of three coal-tar based enamels used in contact with potable water with three similar paints with an asphalt base. The results demonstrated that coal-tar enamels contained very high levels of mutagenic activity, whereas asphalt-based enamels were without measurable activity. As little as 0.2 ml (single dose) of a coal-tar based paint applied topically was capable of initiating tumors in more than 50% of the animals treated; it required 200 ml to produce a comparable response with asphalt-based enamels. Additionally, the one coal-tar paint and one asphalt-based enamel were tested as whole carcinogens using weekly applications to the shaved back for 20 weeks. The coal-tar paint was active at a dose of 2 ml week, whereas the asphalt paint was inactive at 200 ml week. These data will assist the Agency in reviewing coal-tar products in potable water systems.

The current water quality standard for bathing waters was established in 1968. The data upon which that standard was based have recently been the object of considerable criticism. In 1983, researchers at the health laboratory completed a series of marine and fresh water epidemiological and microbiological studies in an effort to update the data base. The studies were designed to produce criteria, defined as mathematical relationships between undesirable health effects due to swimming in sewage-polluted water and some microbial measure of water quality. These criteria could be used by regulatory or enforcement agencies at the federal, state, and local levels to set guidelines and standards.

Epidemiological studies were conducted at several locations, covering both marine and fresh recreational waters. Swimmer and nonswimmer volunteers at these locations were contacted 8 to 9 days after their initial beach interview to determine if they had become ill with gastrointestinal, respiratory, or other types of symptoms since their beach visit. Swimming-associated illness rates were estimated by subtracting the nonswimmer illness rates from the illness rates in swimmers, and the water quality was measured. The results of the marine recreational water quality studies indicate that a direct log linear relationship exists between swimming associated gastroenteritis rates and one indicator of water quality, enterococci. The results of fresh recreational water quality studies indicate that a direct log linear relationship exists between swimming-associated gastroenteritis rates and two indicators of water quality, *E. coli* and enterococci. These relationships provide meaningful criteria which can be used to extrapolate acceptable risk levels to corresponding indicator densities.

OHEA

Office of Health and Environmental Assessment

This office evaluates the effects of environmental pollutants, in varying exposure situations, on human health and ecological systems. This information is used by the Agency in the implementation of its statutory responsibilities. The office is composed of five elements: the Environmental Criteria and Assessment Office in Research Triangle Park, North Carolina, has its major emphasis in the air area; the Environmental Criteria and Assessment Office in Cincinnati, Ohio, is oriented toward water, solid waste, and Superfund; the Carcinogen Assessment Group assesses the risk of exposure to potential human carcinogens; the Reproductive Effects Assessment Group evaluates the risks associated with chemicals that are suspected of causing mutagenic, teratogenic, and other reproductive effects; and the Exposure Assessment Group conducts exposure assessments, provides guidance for conducting exposure assessments, and reviews exposure assessments prepared by other EPA offices.

This office produces health and risk assessment documents and air quality criteria documents in support of the regulation of ambient air criteria pollutants or hazardous air pollutants. In 1983, a review draft of the "Revised Evaluation of the Health Effects Associated with Carbon Monoxide Exposure: An Addendum to the 1979 Air Quality Document for Carbon Monoxide" was completed. The "Review of Criteria for Vapor-Phase Hydrocarbons" was issued as a final document when the ambient standard for hydrocarbons was rescinded by the Agency, and the external review draft of the Air Quality Criteria for Lead was completed.

Health assessment documents contain health effects and risk assessment information used by the Agency to decide whether certain substances should be listed as hazardous air pollutants. Before publication in final form, drafts of such documents undergo review by Agency and non-EPA experts in workshops and additional, independent peer review by members of the Agency's Science Advisory Board (SAB). In 1983, final documents for toluene, acrylonitrile, methyl chloroform, chlorofluorocarbon-113, and arsenic were completed. Revisions following workshops or earlier SAB review were also made in drafts for coke oven emissions (completed in early 1984) and for carbon tetrachloride and manganese, as well as for trichloroethylene, tetrachloroethylene, methylene chloride, nickel, chromium, cadmium, chloroform, epichlorohydrin, vinylidene chloride, ethylene oxide, ethylene dichloride, dioxins, chlorinated benzenes, and hexachlorocyclopentadiene (in preparation for SAB review and/or completion later in 1984).

Thirteen ambient water quality criteria documents were updated in 1983. A peer review workshop on the ambient water quality criteria document for dioxins was held and the criterion derivation for dioxin was updated. Draft interim criteria summary statements were prepared for acetone, chlorophenoxy herbicides, dibenzofurans, iron, malathion, manganese, and methoxychlor. Criteria need/feasibility profiles have been completed for aluminum, boron, demeton, guthion, nitrites/nitrates, PBBs, and phosphorus.

Drinking water criteria documents were prepared on 1,1-dichloroethane, mercury, and silver. Peer review workshops were conducted for the silver and mercury criteria documents and the cancer potency values for 14 volatile organic compounds, such as vinyl chloride, trichloroethylene, and methyl chloroform, were verified and updated.

In 1983, 48 hazard profiles were updated. The original cancer evaluation of the dioxin health and environmental effects profile was updated, including an interpretation of pathology findings of the hex isomer.

Two hundred and forty-four reportable quantity documents based on chronic toxicity were prepared as well as the methodology for deriving reportable quantities. Hazard ranking profiles for carcinogenicity on 192 chemicals were completed in 1983 and will be forwarded in the summer of 1984 to the Agency's Superfund program. These profiles summarize available carcinogenicity data that serve as a scientific basis to support rulemaking decisions which establish levels for reporting on hazardous substances.

Documentation in support of the Agency's health assessment on arsenicals was completed for the Agency's pesticide program. The arsenicals were in the Rebuttable Presumption Against Registration stage in 1983, which required a series of evaluations and issue resolutions regarding carcinogenicity. The cancer assessment on lindane was completed, as was the mutagenicity assessment for creosote/coal tar, and the reproductive effects of linuron were reviewed.

As part of the revision and development of risk assessment guidelines, OHEA held workshops in 1983 to discuss key issues relevant to developing guidelines for assessing complex chemical mixtures. The guidelines cover six areas and should be completed in 1984. The six areas are carcinogenicity, mutagenicity, reproductive effects (including teratogenicity and male and female infertility), systemic toxicants (other chronic effects), complex mixtures, and exposure assessment.

OER Office of Exploratory Research

Finally, the exploratory research office focuses on long-range research and analyses of emerging problems. This office has the following major areas of responsibility: managing EPA's acid deposition research program, managing our competitive research grants and university research centers program, and performing strategic analyses of environmental trends and emerging technologies.

The principal areas of interest of the Exploratory Research Grants Program are:

- Environmental biology, ecology, and microbiology
- Environmental health
- Environmental engineering
- Environmental chemistry, physics, and measurements

The *research center program* was evaluated in 1983 and management changes were implemented to improve EPA laboratory and program office interaction. A major effort was also instituted to compile and disseminate center research results initiated in 1981-1983. The research centers are:

Waste Elimination: (Illinois Institute of Technology and the University of Notre Dame) Innovative technology and process modification to reduce industrial pollutants.

Intermedia Transport: (University of California at Los Angeles) Definition of chemical/physical processes governing pollutant exchange at air-land and air-water boundaries.

Ecosystem Management: (Cornell University) Identify and apply ecosystem principles to environmental management problems.

Marine: (University of Rhode Island) Assess marine ecosystem health, emphasizing exposure of marine organisms to toxics.

Advanced Control Technology: (University of Illinois, Urbana) Separation technology, thermal destruction, biological separation, and chemical detoxification.

Ground Water: (University of Oklahoma, Oklahoma State University, and Rice University) Subsurface characterization, transport and fate, and groundwater horizon modelling.

Epidemiology: (University of Pittsburgh) Basic epidemiology methods and airborne particulate health effects.

Hazardous Waste: (Louisiana State University) Design, construction, maintenance, operation, and closure of hazardous waste landfills.

Research into the causes and effects of acid deposition is one of the highest priority environmental programs in the federal government. A task force of 14 agencies is currently working to develop the information necessary to determine what action should be taken to mitigate and control the harmful effects of acid deposition.

One important function of the task force is to encourage and support the sharing of information. The Acid Deposition System (ADS) for data storage and statistical reporting of atmospheric deposition data has been established by the EPA at the Pacific Northwest National Laboratories. The ADS data base system provides an integrated, centralized data bank for atmospheric deposition data collected by all monitoring networks in North America. The purpose of the centralized data base is to (1) facilitate access to deposition data collected by different organizations; (2) provide annual inventories of available data; and (3) maintain the data for the assessment of long-term national trends.

In order to help assure the usability of data being gathered, EPA distributed a quality assurance manual covering both laboratory and field measurements to aid agencies measuring acid rain. The first part of the manual identifies procedures to document the quality of the data collected. The second part of the manual provides general guidance on the operation and maintenance of wet precipitation samplers and the associated ancillary and analytical equipment.

Sophisticated systems for testing the effects of acid rain on field crops have been completed and successfully used. During the 1983 growing season, simulated acid rain did not affect potato tuber number or weight. Foliar necrotic lesions were detected on soybean seedlings exposed to pH of 3.2 or less. Total leaf area damaged was small; it

remained constant until after flowering and had little effect on yield. Two varieties of corn were found to be insensitive to acid rain as strong as pH 3.4 after one season of testing. Two varieties of soybeans were tested with acid rain in Illinois and one, Williams, was found to be insensitive, whereas another, Amsoy, showed a 10% decrease in yield at a pH of 4.2. This is similar to results previously found at Brookhaven National Laboratory and represents multiyear experiments.

Accurate, long distance tracking of pollutants vented out of the mixed layer by convective clouds may now be possible. An airborne, two wavelength lidar system has been successfully developed that can locate a cloud of nontoxic fluorescent paint pigment dye particles (FDP). This new technique was tested and demonstrated in experiments conducted in association with the recent Cross Appalachian Tracer Experiments (CAPTEX). Tracers were released from Dayton, Ohio, and Sudbury, Ontario. The cloud was tracked at altitudes above the mixed layer to simulate the long distance transport of mixed layer pollutants vented out of and above the mixed layer by convective cloud activity. The experiments served to demonstrate and refine the tracer technology and to provide a data base for describing and evaluating atmospheric transport and diffusion modules in regional air quality models.

Another particularly important project in the Acid Deposition research program is the development of the Advanced Utility Simulation Model (AUSM). When completed, this model will allow the Assessment and Policy Analysis Task Group to evaluate national and regional costs and changes in emissions that would result from a wide range of control strategies for electric utilities. In 1983, an initial state-level version AUSM was assembled and transferred to the EPA computing facility at Research Triangle Park, North Carolina. Test runs were performed to demonstrate the transferability of the model to alternate computing systems. Results of test runs for West Virginia were presented to a potential user's group in September, 1983. Further review and documentation is underway. Work began on developing a national-level AUSM that will include refinement of the algorithms and associated data bases in the model. The model will be externally reviewed and subsequently released.

Three thousand copies of the draft, "The Acidic Deposition Phenomenon and Its Effects: Critical Assessment Review Papers" (EPA-600/8-83-016A&B), were printed and distributed for public comment in June, 1983. Fifty-three reviewers returned 130 sets of comments during the 45-day public comment. These comments will go into a final revision of the document and a summary Critical Assessment Document. The draft was generally quite well received by the reviewers, and areas of consensus and continuing uncertainty were emphasized by the range of comments.

Research by other agencies has shown a direct relationship between lung cancer and exposure to radon. This has been especially noted in areas of this country where significant levels of radon are present in household water supplies (e.g., Maine and the Midwest). Radon is released to the indoor air from shower and tap water.

A project has shown that granular activated carbon (GAC) treatment is very effective in removing radon on a continuous basis over long periods of time. It is the first effective means to do this that can be installed easily in homes at a reasonable cost. It was found that the activated carbon enables the establishment of an equilibrium in radon adsorption and decay; that is, the rate of buildup of radioactive radon is equal to the rate of decay of the radon. This explains why the GAC unit can operate for an extended time, since essentially no radon escapes the adsorption process and the adsorptive capacity is not reduced. If the granular activated carbon did not require occasional washing due to other impurities in the water supply, the unit would never require attention.

Another project supported by this office resulted in the development of an electrochemical detection technique for use in conjunction with high performance liquid chromatographic (HPLC) systems to detect carbamate and urea-based pesticides and phenolic compounds in water. These compounds are non-volatile and not readily detected by normal gas chromatographic techniques. Available liquid chromatographic procedures are not sufficiently sensitive without extensive pretreatment, including preconcentration and derivatization. Even then, the achievable detection limit is 0.5 nanograms at best. A detection limit in the picogram range is desirable.

As a result of this research project, an amperometric electrochemical detector was developed for use with HPLC. The liquid chromatograph electrochemical detector system was applied to river water spiked with aminocarb,

carbendazim, desmedipham and dichloran. The detection limits were in the low to mid-picogram range, thus providing for determination of concentrations in the parts per billion range in a 20 microliter sample. Of particular advantage is the fact that little pretreatment is needed.

*USGPO: 1984 — 759-102/10638